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Li'ang Zhang [1], Bazhan Turebekova[1,2*], Dinara Sultan[3]

[1]Al-Farabi Kazakh National University, Almaty, Kazakhstan
[2]King's College London, United Kingdom
[3]University College London, United Kingdom
*e-mail: k241232@kcl.ac.uk

MAPPING INNOVATIVE CORPORATE ENVIRONMENTAL RESPONSIBILITY RESEARCH: A BIBLIOMETRIC ANALYSIS

Climate challenges are rising fast. This makes Corporate Environmental Responsibility (CER) and innovation very important. The intersection of innovation and Corporate Environmental Responsibility (CER) is fast becoming a cornerstone of sustainable development, driven largely by escalating climate pressures. However, the scholarly landscape remains disjointed, often failing to cohesively link technological advancements with financial mechanisms and their actual environmental impacts. To bring order to this fragmented field, we mapped the evolutionary path of innovation-centric CER. Following the PRISMA protocol, we screened 497 peer-reviewed articles from the Web of Science Core Collection (up to April 2025), employing VOSviewer and Biblioshiny for visualization. What stands out is the exponential rise in output, with China functioning as the primary research hub. Thematically, we observed a distinct pivot: the conversation is drifting away from internal metrics like "environmental strategy" and "eco-efficiency," focusing instead on external catalysts such as "green finance," "digital transformation," and "financing constraints." By categorizing the literature into strategic management, sustainable production, and the finance-innovation nexus, this paper offers a consolidated framework. It ultimately lays out a future research agenda to help scholars and practitioners navigate the twin hurdles of digital and green transitions.

Keywords: Corporate Environmental Responsibility, Innovative Approaches, Bibliometric Analysis, Sustainability Strategies.

Ли'анг Чжан[1], Туребекова Бажан*[1,2] , Султан Динара[3]

[1]Әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан
[2]Лондон Корольдік Университеті, Лондон, Ұлыбритания
[3]Лондон Университеттік Колледжі, Лондон, Ұлыбритания
* e-mail: k241232@kcl.ac.uk

Қоршаған орта саласындағы инновациялық корпоративті жауапкершілікті зерттеу картографиясы: библиометрикалық талдау

Климаттық сын-қатерлердің жедел күшеюі корпоративтік экологиялық жауапкершілікке (Corporate Environmental Responsibility, CER) және инновацияға деген назарды айтарлықтай арттырып отыр. Климаттық қысымның өсуі жағдайында инновация мен корпоративтік экологиялық жауапкершіліктің тоғысуы тұрақты дамудың маңызды тірегіне айналуда. Алайда қазіргі ғылыми әдебиетте бұл бағыт әлі де фрагменттелген күйде қалып, технологиялық жетістіктердің қаржылық механизмдермен және олардың нақты экологиялық әсерлерімен өзара байланысы жеткілікті түрде жүйеленбеген. Осы олқылықтың орнын толтыру мақсатында зерттеу инновацияға бағдарланған корпоративтік экологиялық жауапкершіліктің эволюциялық даму траекториясын кешенді түрде талдауды көздейді. PRISMA протоколына сәйкес, Web of Science Core Collection дерекқорынан 2025 жылдың сәуір айына дейін жарияланған 497 рецензияланған ғылыми мақала іріктелді. Библиометриялық талдау мен визуализация VOSviewer және Biblioshiny бағдарламаларының көмегімен жүзеге асырылды.

Зерттеу нәтижелері тақырып бойынша жарияланымдардың экспоненциалды өсуін көрсетіп, Қытайдың жетекші зерттеу орталығы ретіндегі рөлін айқындайды. Тақырыптық талдау ғылыми фокустың айқын өзгерісін анықтады: зерттеулердің бастапқы кезеңдерінде басым болған «экологиялық стратегия» мен «эко-тиімділік» секілді ішкі ұйымдастырушылық аспектілер біртіндеп «жасыл қаржы», «сандық трансформация» және «қаржыландыру шектеулері» сияқты сыртқы катализаторларға ауысқан.

Әдебиеттерді стратегиялық басқару, тұрақты өндіріс және қаржы мен инновация арасындағы өзара байланыс бағыттары бойынша жүйелеу арқылы мақала біріктірілген аналитикалық құрылым ұсынады. Зерттеу нәтижелері ғалымдар мен практиктер үшін цифрлық және жасыл трансформацияның қатар жүруінен туындайтын күрделі сын-қатерлерді еңсеруге бағытталған болашақ зерттеу күн тәртібін қалыптастыруға негіз болады.

Түйін сөздер: корпоративтік экологиялық жауапкершілік, инновациялық тәсілдер, библиометриялық талдау, тұрақты даму стратегиялары.

Лианг Чжан[1], Б. Туребекова[1, 2*], Д. Султан[3]

[1]Казахский национальный университет имени аль-Фараби, Алматы, Казахстан
[2]Королевский университет Лондона, Лондон, Великобритания
[3]Университетский колледж Лондона, Лондон, Великобритания
*e-mail: k241232@kcl.ac.uk

Картография исследований инновационной корпоративной ответственности в области окружающей среды: библиометрический анализ

Стремительное усиление климатических вызовов существенно повышает значимость корпоративной экологической ответственности (Corporate Environmental Responsibility, CER) и инноваций. В условиях нарастающего климатического давления взаимодействие инноваций и корпоративной экологической ответственности становится одним из ключевых факторов обеспечения устойчивого развития. Вместе с тем современное научное пространство по-прежнему характеризуется фрагментарностью, что затрудняет интеграцию технологических достижений с финансовыми механизмами и оценку их реального экологического воздействия.

В целях систематизации данного исследовательского направления в работе проводится комплексный анализ эволюционной траектории развития корпоративной экологической ответственности, ориентированной на инновации. В соответствии с протоколом PRISMA из базы данных Web of Science Core Collection были отобраны 497 рецензируемых научных публикаций, опубликованных до апреля 2025 года. Для проведения библиометрического анализа и визуализации данных использовались программные инструменты VOSviewer и Biblioshiny.

Результаты исследования свидетельствуют об экспоненциальном росте научных публикаций по рассматриваемой тематике, при этом Китай выступает в качестве ведущего исследовательского центра. Тематический анализ выявил отчетливый сдвиг исследовательского фокуса: от преимущественного внимания к внутренним организационным аспектам, таким как «экологическая стратегия» и «экоэффективность», к рассмотрению внешних факторов и катализаторов, включая «зеленые финансы», «цифровую трансформацию» и «финансовые ограничения».

Систематизация научных работ по направлениям стратегического управления, устойчивого производства и взаимосвязи финансов и инноваций позволила предложить интегрированную аналитическую структуру. Полученные результаты формируют основу для определения перспективной исследовательской повестки, ориентированной на преодоление двойственного вызова цифровой и зеленой трансформации, и представляют практическую ценность как для исследователей, так и для специалистов-практиков.

Ключевые слова: корпоративная экологическая ответственность, инновационные подходы, библиометрический анализ, стратегии устойчивого развития.

Introduction

The escalating severity of global environmental problems presents a formidable challenge to sustainable global economic and social development. Consequently, the role and responsibilities of corporations in mitigating environmental degradation have gained unprecedented attention. Corporate Environmental Responsibility (CER), evolving beyond mere regulatory compliance, is increasingly recognized as a strategic imperative and a potential source of core competitiveness for firms navigating the complexities of the 21st century. Concurrently, innovation, particularly environmentally focused "green innovation," is widely acknowledged as a key mechanism for enhancing environmental performance and driving the transition towards sustainability. Therefore, understanding the innovative approaches that firms employ to develop and implement effective CER strategies is a topic of high relevance. This relevance stems from both the widespread academic and practical interest in corporate sustainability and the critical need for actionable strategies that reconcile economic objectives with environmental stewardship.

Despite the growing body of research exploring CER and green innovation individually, and the existence of narrative reviews focusing on specific aspects like eco-innovation drivers (Hojnik & Ruzzier, 2016) or the eco-innovation-competitiveness link (Carrillo-Hermosilla et al., 2010), a significant "problem situation" exists, there is a lack of a comprehensive, systematic, and objective analysis mapping the entire global research landscape specifically dedicated to "innovative approaches to CER strategies". Existing qualitative reviews, while valuable, often lack the scope and quantitative rigor to capture the holistic knowledge structure, evolutionary pathways, and intellectual interconnections within this specific, interdisciplinary domain. This knowledge gap hinders a consolidated understanding of the field's accumulated wisdom, dominant paradigms, influential contributions, and emerging frontiers. The relevance of addressing this topic is underscored by the need for a clearer, data-driven picture of research trends to guide future scholarly inquiry (theoretical significance) and to inform corporate managers and policymakers seeking effective, innovation-driven environmental strategies (practical significance). This study employs bibliometric analysis, a robust quantitative method for mapping scientific fields (Zupic & Čater, 2015), to provide this needed comprehensive overview.

The object of this research is the global scholarly literature focusing on the application of innovative approaches to corporate environmental responsibility strategies. The subject is the intellectual and social structure of this research field, including its knowledge base, thematic evolution, core research topics, influential actors (authors, institutions, countries), research frontiers, and collaboration patterns.

The overarching goal of this paper is to present a systematic and visual map of this research domain through bibliometric analysis, thereby demonstrating its structure and evolution.

To achieve this goal, the specific objectives are:

1. To identify the publication trends and growth trajectory of research in this field.

2. To determine the core research themes, influential publications, key authors, leading institutions, and major contributing countries/regions.

3. To reveal the underlying knowledge structure and foundational literature through co-citation analysis.

4. To map current research frontiers and emerging hot topics using keyword co-occurrence and bibliographic coupling analyses.

5. To characterize the collaboration networks among authors, institutions, and countries.

The methodology adopted is bibliometric analysis. Data was collected from the Web of Science (WoS) Core Collection database. Analytical methods include descriptive statistics, co-citation analysis (Small, 1973), keyword co-occurrence analysis (Callon et al., 1991), bibliographic coupling (Kessler, 1963), and collaboration network analysis. Analysis and visualization were conducted using the VOSviewer software (van Eck & Waltman, 2010) and the Bibliometrix R package (Aria & Cuccurullo, 2017). The study operates under the implicit hypothesis that bibliometric methods can effectively uncover and represent the intellectual structure and developmental dynamics of the target research field. The value of this work lies in providing a structured, evidence-based panorama of the field, offering a navigational guide for academics, actionable insights for managers developing innovative CER strategies, and relevant information for policymakers promoting corporate sustainability.

Literature review

This review covers foundational and recent English-language works germane to innovative approaches in corporate environmental responsibility (CER) strategies, analyzing their scientific contributions and identifying the research gap this bibliometric study aims to fill.

Foundational Concepts: Strategic CER and Stakeholder Influence The understanding of CER has evolved significantly from a compliance-driven necessity to a strategic asset. A pivotal scientific contribution came from Hart (1995), who proposed the natural-resource-based view, positioning environmentally oriented capabilities as unique firm resources potentially leading to sustained competitive advantage. Complementing this, Porter and Van der Linde (1995) argued against the perceived environment-economy trade-off, suggesting that environmental regulation could spur innovation and enhance competitiveness, another key contribution shifting the discourse. Elkington (1997) further broadened the scope with the "triple bottom line" concept, emphasizing the equal importance of economic, social, and environmental performance, a contribution that embedded CER within a holistic sustainability framework. Stakeholder theory also provided a crucial lens; Freeman (1984) offered a foundational contribution by highlighting the necessity for firms to manage relationships with various

stakeholders (including those with environmental concerns) for strategic success. Clarkson (1995), M. B. E. Clarkson's 1995 SMJ paper on stakeholder framework, made a contribution by differentiating stakeholder issues based on their relevance to corporate environmental performance.

The Emergence and Importance of Green Innovation Innovation focused on environmental benefits became a distinct research stream. Rennings, K. (2000) contribution was to define and categorize "eco-innovations," distinguishing them by their positive environmental impact. Subsequent research explored the characteristics and impacts of various green innovation types (e.g., product, process, organizational). Chen et al. (2006) provided empirical contribution by demonstrating a positive link between green innovation performance and corporate advantage in Taiwan. Wagner (2007) investigated the relationship between environmental management, environmental innovation, and patenting, contributing to understanding innovation outputs.

Integrating Innovation into CER Strategies and Performance Research increasingly focused on the strategic integration of innovation within CER. A significant contribution by Sharma and Vredenburg (1998) was distinguishing between reactive and proactive environmental strategies and linking proactive stances to the development of unique organizational capabilities, often innovation-driven. Russo and Fouts (1997) made an early empirical contribution suggesting a positive relationship between environmental performance and financial performance, often mediated by factors like innovation. Aragon-Correa and Sharma (2003) contributed by applying the dynamic capabilities perspective to understand proactive environmental strategy formulation. Aguilera-Caracuel et al. (2012) explored how international experience fosters organizational learning that influences proactive (and often innovative) environmental strategies, a contribution linking globalization and CER. Studies also examined the diverse drivers of green innovation adoption, such as regulations, market pull, and technology push (Horbach et al., 2012), and the role of stakeholder pressure (Qi et al., 2010), providing contributions to understanding the contextual factors. Christmann (2000) contributed by empirically examining the effects of environmental management practices (often involving process innovation) on cost advantage.

Existing Syntheses and the Identified Research Gap While the aforementioned works represent significant individual contributions, efforts to synthesize the field have also emerged. Reviews by Hojnik and Ruzzier (2016) on eco-innovation drivers and Carrillo-Hermosilla et al. (2010) on eco-innovation and competitiveness offer valuable thematic summaries. Zhu and Sarkis (2004) contributed reviews focused on green supply chain management, an area related to operational innovation for CER. However, these reviews are typically narrative, selective in scope, or focused on sub-domains of the broader field.

The specific research gap addressed by the present study is the absence of a large-scale, quantitative, and visual mapping of the entire intellectual structure and evolution of the research field specifically focused on 'innovative approaches to corporate environmental responsibility strategies' globally. Unlike previous reviews, this study employs bibliometric methods (Zupic & Čater, 2015) to analyze the entire relevant literature corpus retrieved from WoS based on objective criteria. Its contribution is not a narrative review of findings, but rather a structural analysis of the field itself – identifying the foundational knowledge base (co-citation), core and emerging themes (keywords), current research frontiers (bibliographic coupling), and collaboration networks – providing a unique, comprehensive, and objective panorama that complements existing qualitative reviews.

Methodology

In order to systematically depict the knowledge map, evolutionary paths and cutting-edge hotpots in the research field of "applying innovative methods to enhance corporate environmental responsibility strategies", the bibliometric methodology is used in this study. This method uses mathematical and statistical tools to quantitatively analyze literature data, which can objectively reveal the intellectual structure and development dynamics of a particular research field (Zupic & Čater, 2015).

The bibliometric analysis and visualization were conducted using VOSviewer (version 1.6.19), developed by the Centre for Science and Technology Studies (CWTS) at Leiden University, The Netherlands (van Eck & Waltman, 2010). Additionally, Biblioshiny, a web-based interface for the Bibliometrix R package (Aria & Cuccurullo, 2017), was employed to perform comprehensive science mapping analysis.

This section will detail the data collection process, the bibliometric analysis techniques employed, and the analytical tools used.

Data collection and preparation

Literature data for this study was obtained from the Web of Science (WoS) core ensemble databases. Three core databases were selected: the Science Citation Index Expanded (SCI-EXPANDED) – 1975-present; Social Sciences Citation Index (SSCI) – 1975-present; Arts & Humanities Citation Index (AHCI)-1975-present; this database was chosen primarily based on its broad disciplinary coverage, rigorous journal selection criteria, and inclusion of complete citation information, which provides the necessary data base for bibliometric studies such as co-citation analysis (Clarivate, 2025).

The data retrieval strategy was designed to comprehensively capture literature that is highly relevant to the research topic. The search formula was set as follows: TS=("environmental responsibility" OR "corporate environmental responsibility" OR "environmental strategy") AND TS=("innovation" OR "innovative approaches" or "green innovation"); The search timeframe covered all records from the database construction to April 12, 2025, and a total of 540 documents were retrieved.

The search subject (TS) field included title, abstract, author keywords, and Keywords Plus to ensure a comprehensive search. To ensure the quality of the documents, the type of documents retrieved was limited to "Document Types: Article or Early Access or Review Article" and the language was limited to "English" the language was limited to "English". The time frame of the search covered all records from the time of database construction to April 12, 2025, and 530 documents were retrieved (Table 1).

Table 1 – Document Types Analysis Data

Field	Record Count	% of 497
Article	485	97.59%
Early Access	30	6.04%
Proceeding Paper	3	0.60%
Review Article	12	2.41%

Note – Compiled by authors based on Web of Science Document Types

Table 2,the initial search yielded a large number of documents, but some of them were of low relevance to the topic of this study. In order to improve the accuracy of the search results, we further limited the Web of Science (WoS) literature categories to Environmental Sciences, Environmental Studies, Green Sustainable Science Technology. Management, Business, Economics, Engineering Environmental, Ethics, Regional Urban Planning, Operations Research Management Science, Multidisciplinary Sciences, Energy Fuels and Energy Technology. Multidisciplinary Sciences, Energy Fuels, Development Studies, Agricultural Economics Policy, Public Environmental Occupational Health, Social Sciences Interdisciplinary. Sciences Interdisciplinary. This optimization resulted in 497 relevant papers. These literatures formed the data base for the subsequent bibliometric analysis.

Table 2 – Statistics of the number of each WOS category

Web of Science Category	Number of Documents
Environmental Sciences	210
Environmental Studies	188
Green Sustainable Science Technology	165
Management	144
Business	141
Economics	42
Engineering Environmental	42
Ethics	19
Regional Urban Planning	19
Operations Research Management Science	12
Multidisciplinary Sciences	11
Energy Fuels	10
Development Studies	9
Agricultural Economics Policy	6
Public Environmental Occupational Health	5
Social Sciences Interdisciplinary	4

Note – Compiled by authors based on Web of Science Categories

Thermodynamics and its subcategories (e.g., Computer Science Cybernetics, Biochemistry Molecular Biology, etc.) have a literature count of ≤3, which is low in relevance to the research topic. Automation Control Systems and its subcategories (e.g., Chemistry Multidisciplinary, Computer Science Artificial Intelligence, etc.) have a very small number of documents (≤2) and are not included in the analysis for the time being.

The initial search yielded a total of 540 documents. Subsequently, a complete record of all lit-

erature was downloaded on April 12, 2025, including information such as title, abstract, keywords, authors, institutions, and references. To ensure the accuracy and relevance of the dataset, data cleaning and preparation were carried out: first, literature that was clearly irrelevant to the topic was excluded; second, possible duplicate records were checked and merged. After screening and cleaning, the final dataset included in the analysis of this study contained 497 documents.

To ensure rigorous methodological curation of the extant scholarship, this inquiry strictly operationalized the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol to disentangle and systematically scrutinize the selected corpus (Moher et al., 2009; Page et al., 2021). Far from a mere heuristic, PRISMA imposes a structural discipline through a granular, four-stage progression: identification, screening, eligibility assessment, and final inclusion (Snyder, 2019). This architectural framework provides a robust scaffold for the screening and synthesis of disparate findings, thereby mitigating selection bias. By maximizing the transparency of the bibliographic acquisition process, the methodology significantly bolsters the epistemic validity and reproducibility of the resultant empirical deductions (Tranfield et al., 2003). Consequently, to construct a cohesive, integrative review of the multifaceted nexus between innovation and Corporate Environmental Responsibility (CER), we adopted the PRISMA guidelines as the foundational instrument for this study. Figure 1 depicts the specific, quantified workflow utilized for data source extraction and filtration.

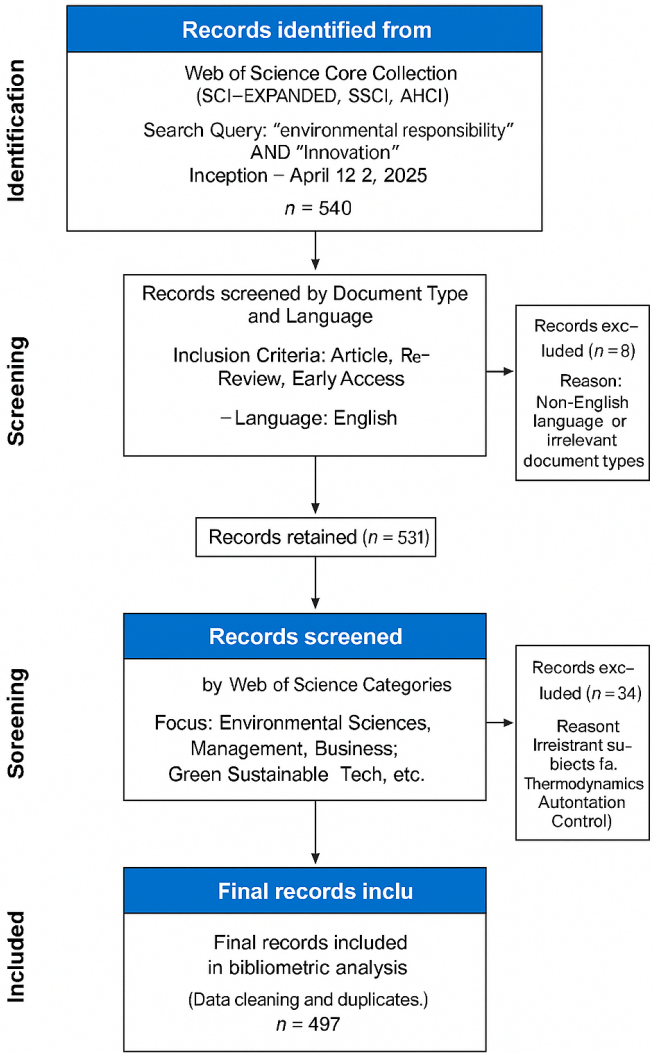

Figure 1 – PRISMA workflow showing the data acquisition process
Note – Compiled by authors based on PRISMA

Research Methods

This study utilizes established bibliometric methods to analyze the collected data quantitatively and map the research field:

Descriptive Statistical Analysis: Basic statistics were calculated to profile the field, including annual publication trends, identification of the most productive authors, institutions, countries/regions, and the most frequent publication sources (journals).

Co-citation Analysis: This technique identifies the foundational knowledge base and intellectual structure of the field by analyzing how often documents, authors, or journals are cited together in the reference lists of the source publications (Small, 1973). High co-citation frequency suggests a strong conceptual relationship between the cited items. This analysis was performed on cited references, cited authors, and cited sources (journals).

Keyword Co-occurrence Analysis: This method examines the frequency with which keywords (author-provided keywords and WoS Keywords Plus®) appear together in the same documents (Callon et al., 1991). Mapping these co-occurrences helps identify the core research themes, hot topics, and the conceptual structure of the field.

Bibliographic Coupling Analysis: This analysis links documents that cite one or more of the same references (Kessler, 1963). Documents with strong bibliographic coupling are likely to address similar research problems or topics, making this method effective for identifying current research fronts and emerging research clusters.

Collaboration Network Analysis: This involves mapping the co-authorship relationships between authors, institutions, and countries/regions. Analyzing these networks reveals patterns of scientific collaboration, identifies key collaborative groups, and highlights the extent of national and international cooperation within the field.

Analytical tools

To perform the above bibliometric analysis and visualize the results, the following two specialized software tools were used in this study:

Bibliometrix R package: This is a comprehensive bibliometric analysis toolkit based on the R language environment (Aria & Cuccurullo, 2017). This study utilized Bibliometrix for data import, preprocessing, descriptive statistical analysis (e.g., annual publications, core author identification, etc.), and the generation of some of the network data matrices.

VOSviewer: This is a software specifically designed for constructing and visualizing bibliometric network mappings (van Eck & Waltman, 2010). VOSviewer is known for its powerful visualization capabilities and user-friendly interface, and is particularly suitable for presenting clustering in large networks (e.g., co-citation networks, keyword co-occurrence networks, literature coupling networks, collaboration networks) structure and inter-item relationships. This study will primarily use VOS viewer to generate and present various bibliometric network maps.

By combining the data processing and preliminary analysis capabilities of Bibliometrix with the advanced visualization capabilities of VOSviewer, this study aims to provide a comprehensive, in-depth, and intuitive analysis of the field of "Innovative Approaches to Enhance Corporate Environmental Responsibility Strategies".

Results and discussion

Findings and descriptive analysis

The aim of this section is to present the main results of the bibliometric analysis of the data set of literature in the field of research on "Innovative approaches to enhancing corporate environmental responsibility strategies" (N=497). Firstly, the results of the descriptive statistical analysis are presented to provide a basic overview of the field and its development, followed by an in-depth discussion of its intellectual structure and research themes.

1) Trends in Literature Publication

Statistics on the year of publication of the 497 documents included in the analysis reveal the characteristics of the temporal evolution of the research field. Figure 2 shows the annual number of publications in the field between 1994 and 2025.

"As shown in Figure 2, between 1994 and 2014, the number of relevant literature published in this field was relatively small and in a slow development stage, and since 2018, the number of literature published has shown a significant growth trend, especially in the period of 2019-2023, which further accelerates the growth rate, reflecting that the "application of innovative methods to improve the This reflects that "using innovative methods to improve corporate environmental responsibility strategy" has gradually become a research hotpots. The increase in publications may be related to the growing global emphasis on sustainability and corporate environmental performance, as well as the increasing role of innovation in addressing environmental challenges. As of April 12, 2024, a cumulative total of 497 publications have been published in the literature."

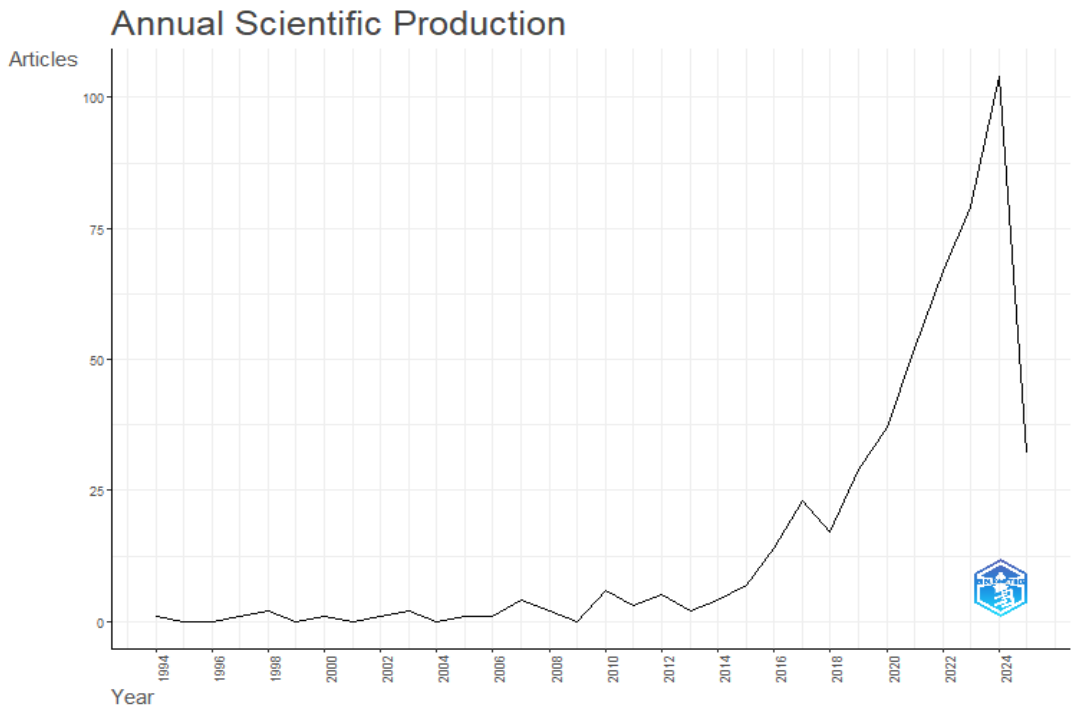

Figure 2 – Trends in the number of annual publications (1994 to 2025)
Note – Compiled by authors based on Bibliometrix

2) Main Source Journals

The distribution of source journals for the literature reflects the main publication platforms for research results in the field and their disciplinary affiliation. Table 3 lists the top 10 journals that have published the highest number of relevant literatures, demonstrating the main vehicles for research results in the field.

As shown in Table 3, relevant research results are mainly published in sustainability, business strategy and the environment, journal of cleaner production, corporate social responsibility and environmental management, and other leading journals in the field. Among them, sustainability and business strategy and the environment are the core journals in the field, publishing a large number of related studies, indicating that the research topic is significantly interdisciplinary, integrating the perspectives of several disciplines, such as environmental sciences, management, economics and innovation studies.

Table 3 – Top 10 journals with the highest number of publications

SOURCES	ARTICLES
Sustainability	96
Business strategy and the environment	51
Journal of cleaner production	39
Corporate social responsibility and environmental management	19
Environmental science and pollution research	16
Journal of business ethics	14
Environment development and sustainability	13
Technological forecasting and social change	10
Journal of environmental management	9
Organization & environment	7

Note – Compiled by authors based on Bibliometrix

3)Highly productive authors

Identifying core researchers helps to understand the distribution of academic power in the field. Table 4 shows the top 10 authors in terms of publications.

Table 4 – The top 10 authors by number of publications

Authors	Articles	Articles Fractionalized
LIU Y	7	1.82
ZHANG L	7	2.10
DANIELE LM	6	1.53
GANGI F	6	1.53
WANG Y	6	1.70
ZHANG C	5	1.92
ZHANG Q	5	1.37
ALI A	4	1.17
FENG TW	4	1.08
JIANG W	4	1.03

Note – Compiled by authors based on Bibliometrix

Table 4 shows the researchers who have contributed the highest number of publications in the field. These prolific authors are usually important scholars in the field, and their research work may have had a significant impact on the direction of the field and research topics. It is important to note that the number of authors' publications only reflects their productivity, and the subsequent analysis of collaborative networks and co-citations will further reveal the collaborative relationships and academic influence among the authors.

4)Major Research Countries/Regions

Analyzing the distribution of countries/regions to which the authors of the literature belong can reveal the geographic concentration of research in the field and the pattern of international cooperation. Figure 3 lists the top 10 countries/regions in terms of the number of publications.

Figure 3 illustrates the contribution of different countries in single-country publications (SCP) and multicountry collaborative publications (MCP) when they are corresponding authors. Among them:

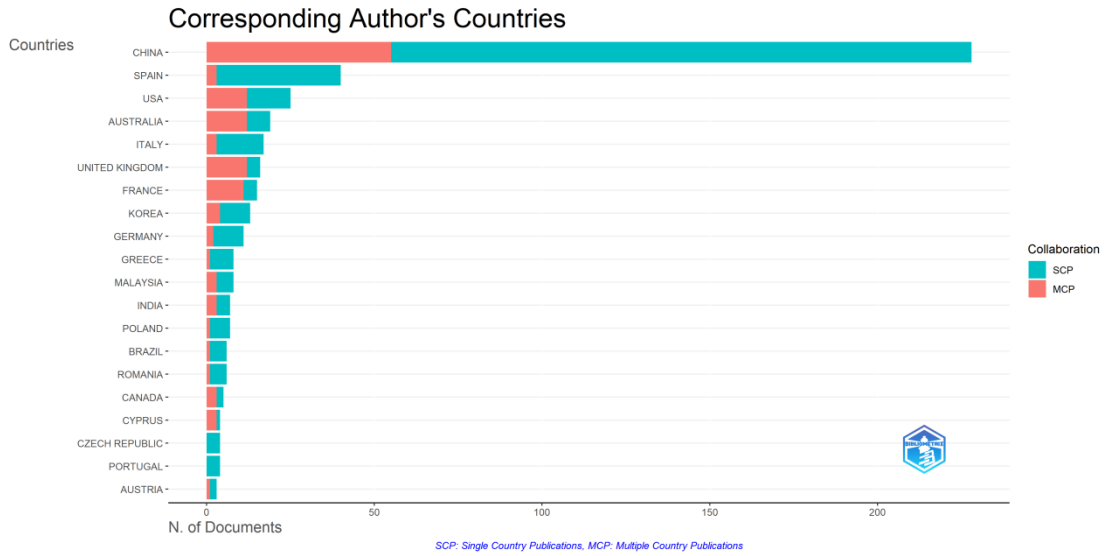

Figure 3 – Top 10 countries/regions by number of publications
Note – Compiled by authors based on Bibliometrix

First, single-country publications (SCP) refer to publications independently completed and published by researchers or institutions in a single country, which are represented by blue bars in the figure, representing scientific research results independently completed by that country.

Second, Multi-country Collaborative Publication (MCP) refers to publications that are jointly completed and published by researchers or institutions from multiple countries, which are represented by red bars in the graph, reflecting transnational scientific research cooperation.

The horizontal axis of the graph indicates the number of publications and the vertical axis lists the individual countries involved in the research. The bar for each country is divided into two parts, corresponding to the number of its SCPs and MCPs.

As can be seen from the graph, China is a significant leader in the total number of publications and has the largest percentage of SCPs, indicating its outstanding independent scientific research capacity as well as its active participation in international collaborations. Countries such as Spain, the United States and Australia have the next highest number of publications, but there is a significant gap with China. Countries such as Italy, the UK and France have relatively small outputs, and Greece, Malaysia and India have an even smaller total amount of literature, but a small amount of independent and collaborative outputs can still be seen. However, scholars in Kazakhstan have not yet conducted research in this area.

Overall, China, Spain, and the United States are the main contributors of research output in this field, which may reflect the policy orientation and academic inputs in these countries in promoting corporate environmental responsibility and fostering green innovation." .

5) Key Research Institutions

Identifying research institutions with outstanding contributions helps to understand the core research strength of the field. Figure 4 shows the top 10 research organizations in terms of publications.

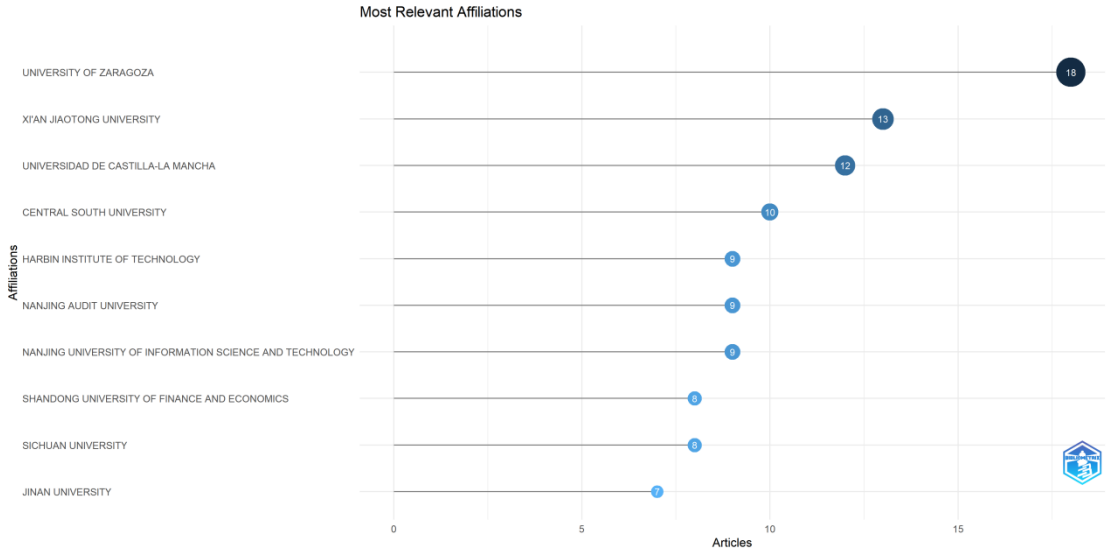

Figure 4 – Top 10 Research Institutions in terms of number of publications
Note – Compiled by authors based on Bibliometrix

Identifying research institutions with outstanding contributions in the field helps to understand the distribution of core research strengths. Figure 4 shows the top 10 institutions in terms of publications, presented as a horizontal bar chart, with the horizontal axis representing the total number of articles published by each institution, the vertical axis listing the name of the institution, and the length of the bar and the value at the end of the bar corresponding to the number of articles published by the institution.

As shown in Figure 4, "University of Zaragoza" tops the list with 18 articles, which is significantly ahead of the other institutions, indicating that it is probably one of the core research centers in the field due to its outstanding research activity and output capacity. It was followed by Xi'an Jiaotong University (13 articles) and Universidad de Castilla-La Mancha (12 articles) in second and third place, respectively. Other institutions such as Central South University and Harbin Institute of Technology also contributed, but with a relatively small number of articles.

In terms of geographical distribution, Spanish institutions (University of Zaragoza, Universidad de Castilla-La Mancha) showed stronger research strength. Meanwhile, Chinese institutions (Xi'an Jiaotong University, Central South University, Harbin

Institute of Technology) also occupy an important position, but the overall number of publications is slightly lower than that of the top Spanish institutions.

This result has important academic implications. First, it visualizes the research output of each institution in this field, which is an important basis for assessing its academic influence and research activity. Second, although the chart does not directly display collaboration information, it can be used in conjunction with the subsequent collaborative network analysis to further explore the position and role of these high-producing institutions in the collaborative network, as well as the potential patterns of collaboration among them. Finally, by comparing the number of publications from institutions in different countries, it is possible to gain a preliminary understanding of the research inputs and outputs in the field in different countries, for example, the comparison between Spanish and Chinese institutions observed in this study may reflect the different stages of development or research focus in the field in the two countries.

Literature measurement results

Based on the descriptive statistical analysis in the previous section, this section uses network analysis techniques to deeply reveal the intrinsic knowledge structure, core research themes, research fronts, and cooperation modes in the research field of "applying innovative approaches to enhance corporate environmental responsibility strategies". The analysis is visualized by VOSviewer software.

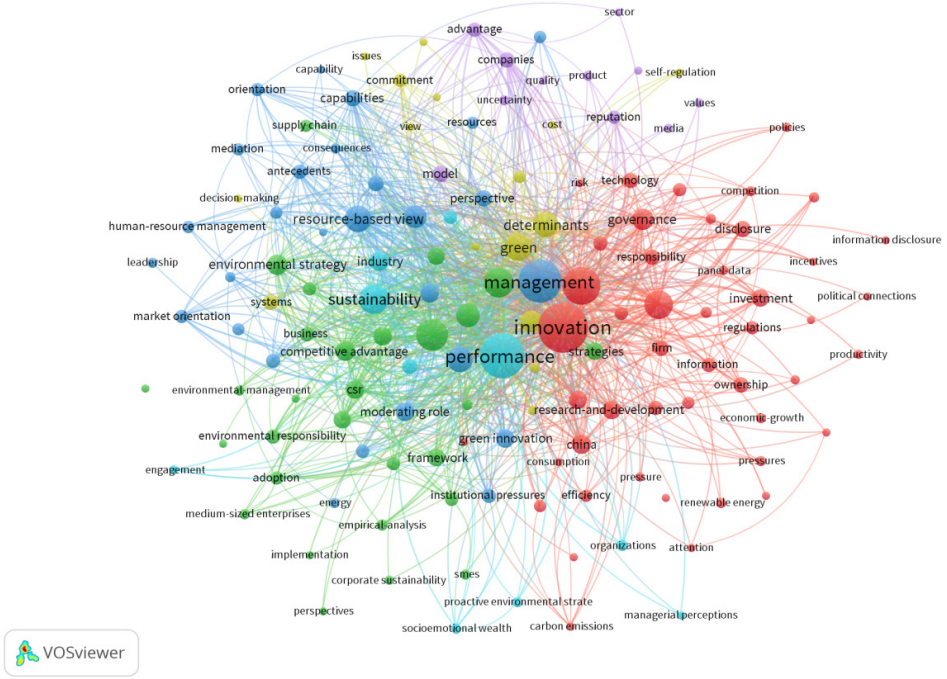

Figure 5 – Keyword co-occurrence analysis
Note – Compiled by authors based on VOSviewer

1) Keyword co-occurrence analysis: research themes and hotspots

Keyword co-occurrence analysis is used to identify the core research themes and hotspots and their interrelationships in a specific field. Figure 5 shows the keyword co-occurrence network diagram constructed based on author keywords and Keywords Plus®. In the analysis, the minimum co-occurrence frequency threshold was set to 5 times, and 141 keywords that reached the threshold were screened out of 887 keywords. In the graph, each node represents a keyword, the node size reflects its frequency of occurrence, and the strength of the connecting line between nodes indicates the degree of co-occurrence closeness. In this section, we will analyze the research themes, hot topics and interrelationships." .

Research theme identification

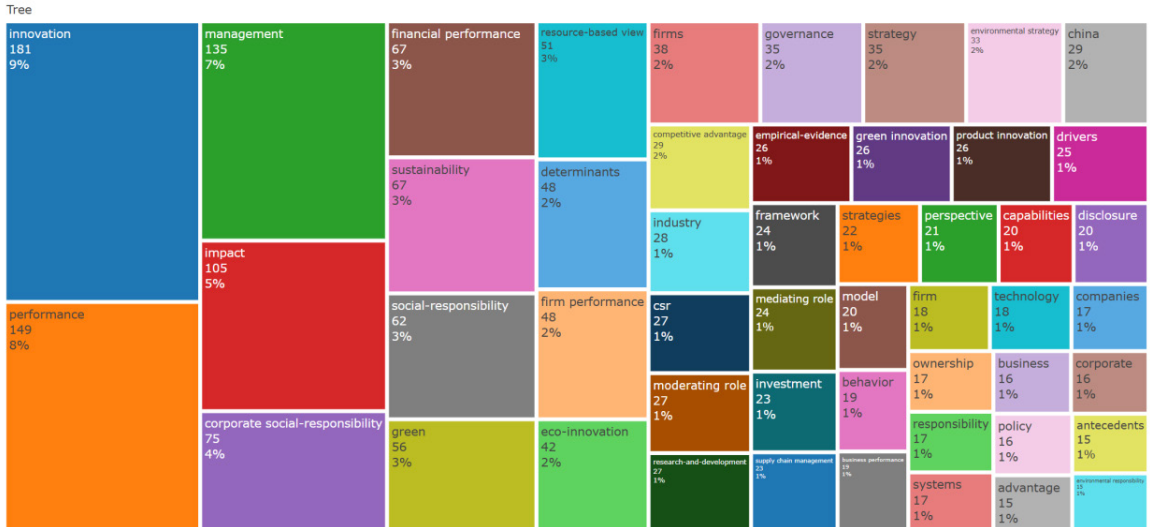

Figure 6 – Keyword co-occurrence analysis
Note – Compiled by authors based on Bibliometrix

The core area of the network graph is dominated by the high-frequency keywords "management", 'innovation' and "performance "indicating that these themes occupy a central position in the relevant research (Figure 6). For example, "management" is associated with "human-resource management" and "leadership". (human-resource management), "leadership" and other sub-themes, highlighting the fundamental role of management practice in academic research. Meanwhile, "innovation" is closely related to keywords such as "research-and-development" and "strategies". The co-occurrence of keywords such as "innovation" with "research-and-development" and "strategies" reveals the intrinsic connection between corporate innovation strategies and R&D activities. In addition, the high frequency of keywords such as "sustainability", "green innovation" and "CSR" reveals the intrinsic connection between corporate innovation strategy and R&D activities. In addition, the high frequency of keywords such as "sustainability", "green innovation" and "CSR" indicates that environmental sustainability and social responsibility have become hot topics in research.

Exploration of Hot Topics

Further analysis shows that the keyword network presents a multi-dimensional research path. With "management" as the core, the keywords "market orientation", "competitive advantage" and so on are derived. The core of "management" is "market orientation" and "competitive advantage", which emphasize the key role of market drive and competitive strategy in enterprise development. In the branch of "innovation", 'firm' and "strategies" co-occur more frequently, reflecting the practical characteristics of enterprises as the main body of innovation. This reflects the practical characteristics of firms as innovation subjects. Performance is associated with keywords such as "efficiency" and "economic growth", emphasizing the importance of performance. "Performance" is associated with keywords such as 'efficiency' and "economic growth", emphasizing the close connection between performance assessment and economic development. It is worth noting that "sustainability" is associated with keywords such as "environmental responsibility" and "renewable energy", "energy" (renewable energy) and so on form an emerging research path, showing that academics continue to deepen their concern for environmental issues.

Interrelationship Analysis

The co-occurrence of keywords reveals the intrinsic connection between topics. For example, the strong correlation between "management" and "innovation" indicates that management practices are closely related to innovation activities; 'performance' and "sustainability" are closely related to innovation activities. The connection between "performance" and "sustainability" suggests the synergy between corporate performance and the SDGs. In addition, keywords such as "information disclosure", 'governance', and "regulations" are also used. " (regulations) are keywords that further expand the perspective of corporate governance and

policy research. These relational networks provide an important basis for understanding the cross-cutting and systemic nature of the research field.

The keyword co-occurrence network map drawn by VOSviewer in this study clearly presents the core themes and hot topics in the field, including the directions of corporate governance, innovation strategy, performance evaluation and sustainable development. Future research can further deepen the exploration of emerging topics such as "green innovation", "environmental responsibility" and "corporate governance" to promote the synergistic development of theory and practice. This analysis provides methodological support for subsequent bibliometric studies, as well as reference for academics and practitioners to grasp research trends and optimize research directions.

2) Literature Coupling Analysis: Research Frontiers

Literature coupling analysis reveals the active frontiers of current research fields by linking the latest literature that cites similar references. Figure 7 shows the literature coupling network constructed based on 497 source documents (the minimum coupling intensity threshold is set to 10 times), in which all the documents meet the minimum citation requirement. By calculating the total strength of literature coupling links between each document and other documents, 287 core documents were finally screened out for analysis, and the VOSviewer software was used to draw the source co-citation network diagram to visualize the correlation between the documents and their distribution characteristics in the research field.

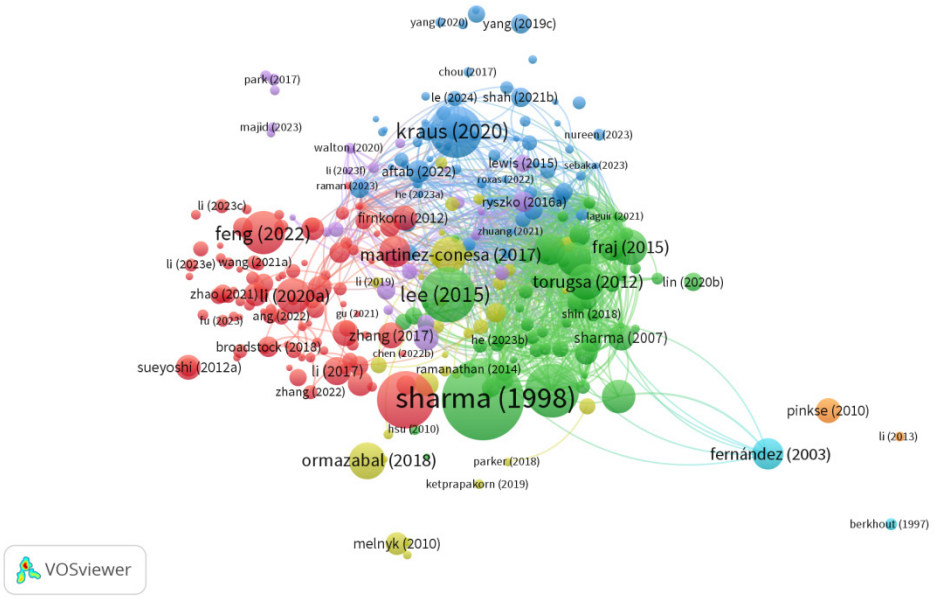

Figure 7 – Literature Coupling Network Diagram
Note – Compiled by authors based on VOSviewer

Network Diagram Construction and Parameter Setting

Data Screening: Set the threshold of the number of citations to 10 to ensure that all 497 documents meet the inclusion criteria.

Calculation of nodes and links: Calculate the coupling strength of 287 core documents with other documents, the size of nodes reflects the influence of the documents, and the strength of links indicates the degree of association between the documents.

Visualization tool: constructing network diagrams through VOSviewer, Figure 7 using color coding to distinguish different literature clusters (e.g., green, blue, and red clusters), and visually presenting the clustering characteristics of the research frontiers.

Literature clusters and research frontiers

Different color node clusters in the network diagram represent the core direction of the research field:

Green cluster: Sharma (1998) is the core, and its node size is large and in the center position, which indicates that the early research results still have important influence on the current research.

Blue cluster: centered on Kraus (2020), with dense connectivity between nodes, reflecting the prominence of emerging research hotspots and trends in recent years.

Red cluster: contains Feng (2022) and Li (2020a), whose strong coupling relationship suggests a common focus on a specific topic or direction, and may represent an independent but important research branch.

Dynamic Characteristics of Research Frontiers

Continuity of classical theories: the green cluster shows that the early literature (Sharma, 1998) is still the theoretical foundation of current research.

Dominance of Emerging Trends: The blue cluster shows that recent literature, represented by Kraus (2020), dominates the direction of the frontier, reflecting the knowledge update and innovation in the field.

Parallel development of multiple directions: the separation of the red cluster from the other clusters implies the existence of multiple independent but complementary research paths in the field, which need to be further analyzed for their thematic relevance.

Literature coupling network diagram reveals the structural characteristics of the research field through visualization:

Influence of core literature: the size and position of nodes directly reflect the pivotal role of literature in the knowledge network.

Dynamics of frontier directions: The comparison of different color groups shows that classical theories and emerging trends coexist, and multi-directional research advances at the same time.

Methodological value: This analysis provides an objective basis for identifying research hotspots and tracking the development of the field, which can provide a reference for subsequent research design and academic resource allocation.

3) Collaborative Network Analysis

This study analyzes the characteristics of collaborative networks at three levels: authors, institutions and countries/regions.

Author Collaboration Network

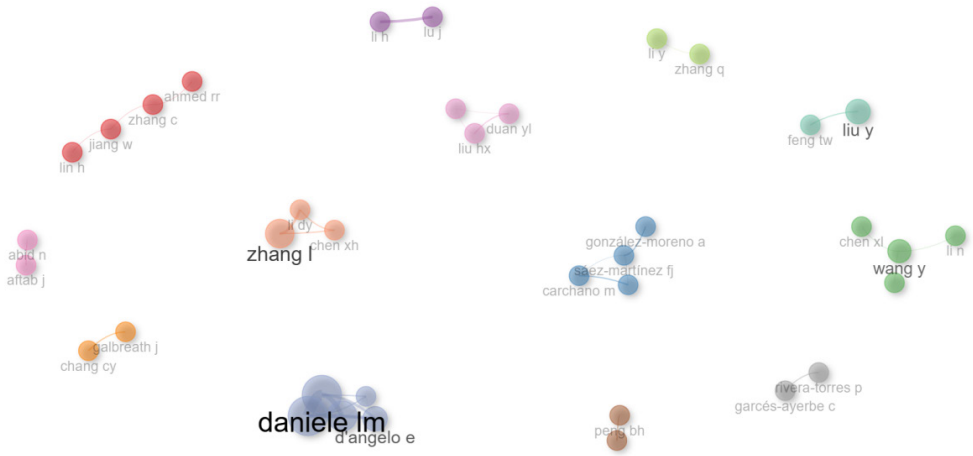

Figure 8 – Author collaboration network
Note – Compiled by authors based on VOSviewer

The author collaboration network shows a significant polycentric structure(Figure 8). Among them, core authors (e.g., gangi f, daniele lm) occupy key positions in the network by virtue of their high connectivity, dominate cross-team collaboration and knowledge dissemination, and have a significant impact on the overall structure of the network. At the same time, there are some smaller collaborative groups in the network (e.g., the subgroups formed by zhang q, duan yl), which are relatively focused in their research direction but have relatively few direct connections with the core authors. In addition, some authors (e.g., rivera-torres p, liu y) are relatively isolated in the network with low connectivity, and future research should focus on how to facilitate the integration of these fringe

authors into the collaborative network to enhance the overall synergistic efficiency of the network. Overall, this author collaboration network has high connectivity, indicating more active knowledge sharing, but the polarization between core and edge authors deserves further attention and should be improved by establishing an effective cross-team collaboration mechanism.

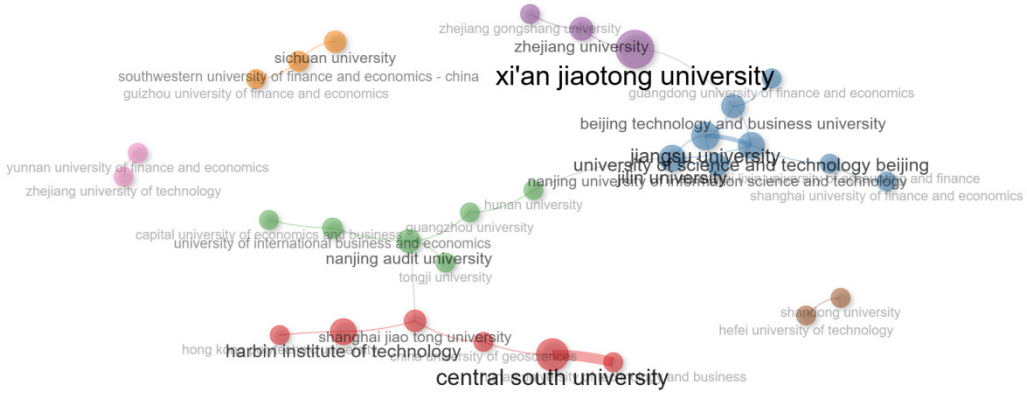

Figure 9 – Institutional collaboration network
Note – Compiled by authors based on VOSviewer

The institutional collaboration network has Xi'an Jiaotong University as its core, and the extensive connectivity of this institution provides the network with significant academic influence and resource integration capabilities(Figure 9). Institutions such as Jilin University and Beijing Institute of Technology also play key roles in the network, further enhancing its stability. In terms of geographic distribution, there are some geographic cooperative subgroups in the network, e.g., the Northeastern cluster of universities centered on Harbin Institute of Technology and the East China cluster of universities centered on Zhejiang University, etc., and the cooperation within these subgroups is relatively close. In addition, there are also some cross-regional institutional collaborations, such as the collaboration between Southwestern University of Finance and Economics and Sichuan University, which play a complementary role in promoting knowledge flows. The analysis of cooperation intensity shows that the cooperation between some institutions is more intensive (e.g. Capital University of Economics and Business and University of International Business and Economics), while the participation of some marginal institutions is relatively low (e.g. Guizhou University of Finance and Economics), and the overall synergistic efficiency of the institutional cooperation network should be improved in the future by optimizing the cooperation mechanism.

The international cooperation network has China as the core hub, and its close cooperation with countries such as South Korea, Japan, and Singapore reflects the dominant position of research collaboration in the Asia-Pacific region (Figure 10). The European Cooperation Circle (Germany, France and the Netherlands) and the Asian Cooperation Circle (centered on China) form a high-density regional network, while the Americas Cooperation Circle (the United States and Canada) has a higher intensity of cooperation but a lower level of participation in South America and Africa. Dynamic analysis shows that international cooperation networks are shifting from being dominated by traditional powers (e.g., the United States and the United Kingdom) to diversified participation, with emerging countries such as India and Brazil contributing to the expansion of the networks. However, regional development imbalances (such as the marginalization of African countries) still need to be improved through policy support and cross-regional cooperation mechanisms.

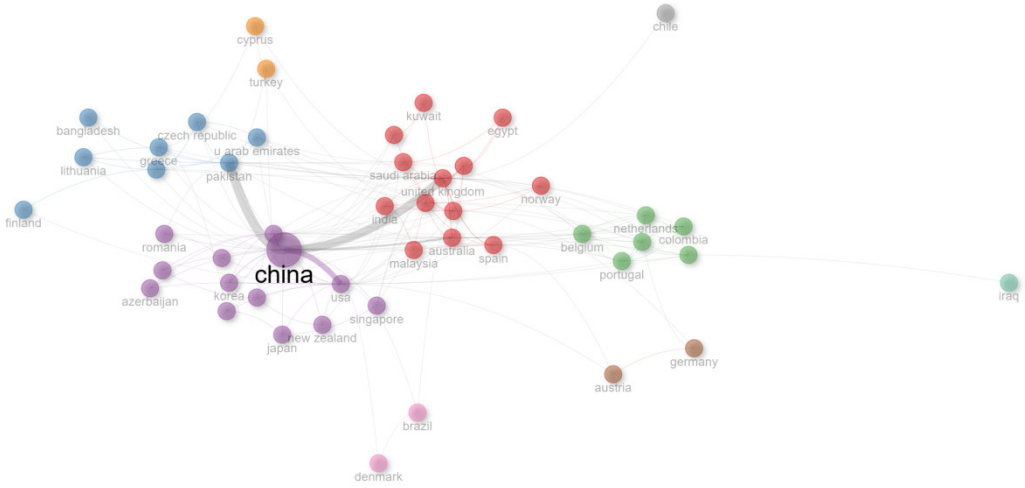

Figure 10 – International Cooperation Network
Note – Compiled by authors based on VOSviewer

Network analysis: co-citation structure and evolution

Based on the previous analysis, this chapter focuses on the co-citation network and utilizes the analytical functions provided by VOSviewer to explore in more depth the knowledge base, cross-disciplinary characteristics, intellectual evolution and the influence of core scholars in the research field of "applying innovative approaches to enhance corporate environmental responsibility strategies", This chapter aims at revealing the knowledge base, cross-disciplinary characteristics, intellectual evolution and influence of core scholars in the field of "applying innovation to enhance corporate environmental responsibility strategies". This chapter aims to reveal the deep structure and dynamic connections within the knowledge network of this field.

Journal co-citation network analysis: assessing sources of knowledge and community cohesion (1994-2025)

Journal co-citation networks reflect the sources of journals that form the knowledge base of the field and their interconnections and help to assess the degree of disciplinary intersections and overall cohesion of the research community.

Purpose of analysis: To identify the core journal communities in the field, to understand the contributions and linkages of different disciplinary knowledge sources (journals), and to assess the degree of knowledge integration in the research community.

By analyzing the co-citation of references cited in 497 documents in the datasets and setting an appropriate co-citation frequency threshold with a minimum of 20 citations, 61 out of 26,878 cited references met the threshold. A literature co-citation network graph can be constructed. Figure 11 illustrates the visualization results of this network.

Literature co-citation network clustering analysis: each node in the graph represents a piece of cited literature, the size of the node usually indicates the citation frequency, the connecting line indicates the co-citation relationship between the literature, and the thickness of the line represents the co-citation intensity. Different colors of nodes represent different research clusters identified by VOSviewer. Based on the content of the node literature and the clustering results, three major knowledge clusters in the field can be identified:

To identify the knowledge base and evolution path of the research field of corporate environmental strategy and green innovation, this paper conducts a cluster analysis based on the literature co-citation network graph drawn by VOSviewer. Each node in the network represents a piece of high-frequency cited literature, the connecting line indicates its co-citation relationship with other literature, the color represents different clustering themes, and the size of the node reflects the citation frequency of the literature. According to the clustering algorithm and graph visualization results of VOSviewer, three major knowledge clusters are identified, which are as follows:

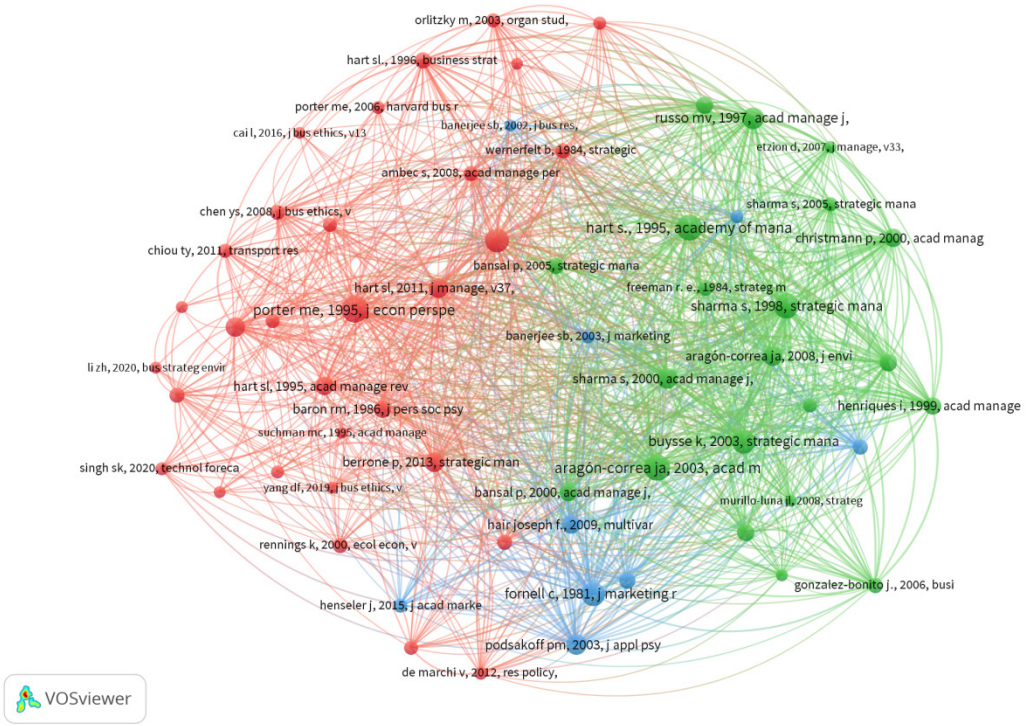

Figure 11 – Literature co-citation network graph
Note – Compiled by authors based on VOSviewer

Cluster 1: Corporate Environmental Strategy and Sustainable Competitive Advantage (Red)

This cluster is the largest and most tightly structured one in the network, which mainly focuses on how corporations can integrate their environmental responsibility into their core strategy in order to achieve sustainable competitive advantage. Representative literature includes Hart (1995) 'A natural-resource-based view of the firm', Porter & van der Linde (1995) 'Toward a new conception of the environment- competitiveness relationship', Porter & van der Linde (1995) 'Toward a new conception of the environment- competitiveness relationship', and Sharma & Vredenburg (1998) among others.

These literatures lay the theoretical foundation for integrating environmental factors into the strategic management system of firms, emphasizing the role of the Resource-Based View (RBV), Stakeholder Theory and Institutional Theory, among others, in environmental strategic decision-making. In addition, this cluster contains a large number of studies on the classification of environmental strategies, environmental driver paths (e.g., market-driven vs. regulation-driven), and the relationship between the performance of environmental strategies, forming the theoretical backbone of the field.

Cluster 2: Green Innovation Drivers and Organizational Response Mechanisms (Green)

This cluster focuses on how a variety of factors, such as external institutional pressures, market pull, and internal capabilities, drive firms to take green innovation actions. Representative literature includes Aragon-Correa & Sharma's (2003) study on environmental strategy response from a dynamic capability perspective, Sharma's (2000) study exploring the relationship between organizational perceptions and environmental commitment, and Russo & Fouts' (1997) study on the positive relationship between environmental performance and financial performance.

This clustering is closely linked and shows that the field of green innovation research is maturing, with the focus shifting from "whether to innovate" to "what drives innovation" and "how organizations respond". The focus of research has gradually shifted from "whether to innovate" to "what drives innovation" and "how organizations respond. In terms of research methodology, the literature in this cluster mostly adopts empirical analysis, integrating

strategic management and organizational behavior perspectives, which is the backbone of green management research.

Cluster 3: Environmental Management Systems and Measurement Tools (Blue)

This cluster covers the research on the operational level of corporate environmental management, including the application of tools such as ISO 14001 environmental management system, Cleaner Production, Life Cycle Assessment (LCA), and the assessment of their effectiveness. Representative literature includes Christmann (2000), Zhu & Sarkis (2004) and Fornell & Larcker (1981), especially the latter's measure of reliability in structural equation modeling, which has been widely borrowed in empirical green management research.

This cluster is closely related to the previous two clusters and serves as a bridge from theoretical research to practical application in business. From the structure of the map, this cluster, despite its relatively small size, has a high degree of concentration, a clear research theme, and significant empirical features, reflecting the reliance on and emphasis on instrumental tools in the process of implementing corporate environmental responsibility strategies. Together, these clusters constitute the intellectual cornerstone of the research field of "applying innovative methods to enhance corporate environmental responsibility strategy".

2)Citation Source Analysis: Tracking the Development of the Field

In order to deeply reveal the knowledge infrastructure of the research field of corporate environmental responsibility and green innovation, this study analyzed the reference sources of the 497 documents collected. In the analysis, the co-citation frequency threshold was set at 20 times, and 236 high frequency cited sources were filtered out from 7,604 sources. Based on the co-citation relationships of these sources, a source co-citation network diagram was drawn using VOSviewer, as shown in Figure 12.

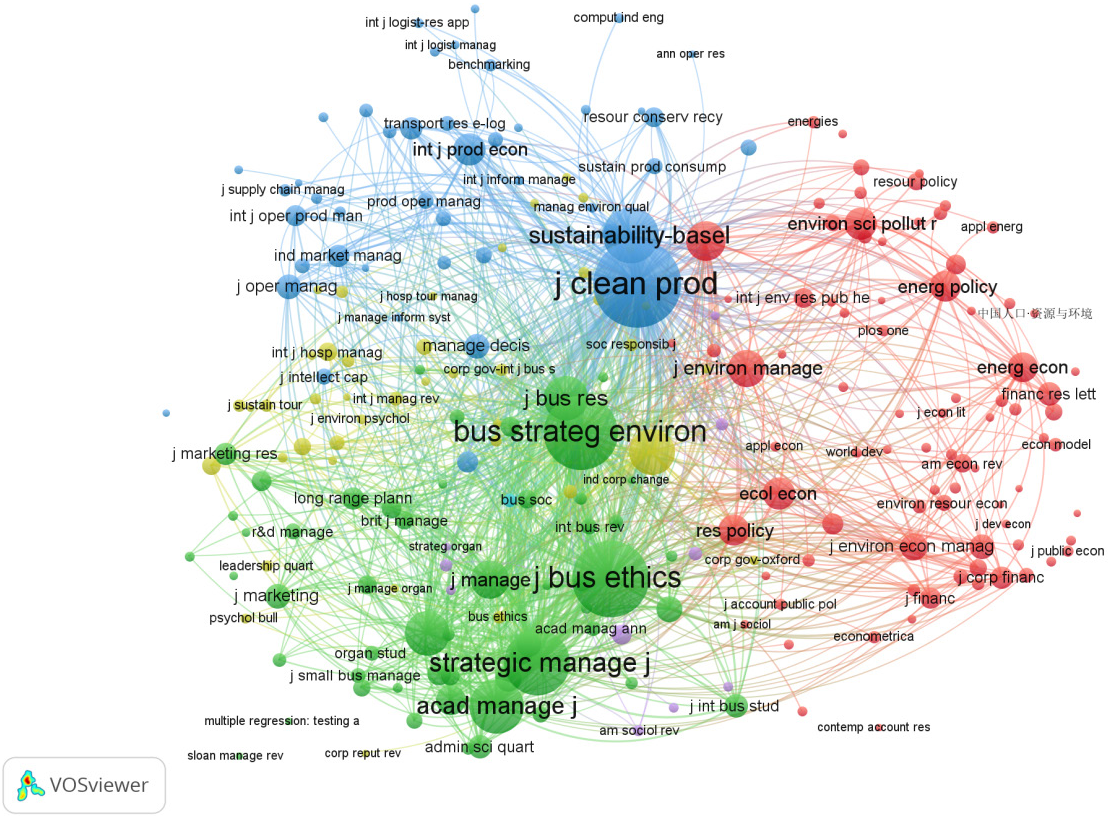

Figure 12 – Literature Citation Source Analysis
Note – Compiled by authors based on VOSviewer

In Figure 12, shows four clear groups of journals. The red cluster includes outlets such as Energy Policy and Ecological Economics. Work in this area often focuses on policy design, energy use, and resource issues. A second group appears in green. Here we see journals like Strategic Management Journal, Academy of Management Journal, and Journal of Business Ethics. These journals connect environmental topics with strategy and organizational behavior (Aragón-Correa & Sharma, 2003; Bansal & Roth, 2000). The blue cluster is more operational. Journals such as Journal of Cleaner Production and Sustainability focus on production systems, efficiency, and circular practices (Rennings, 2000). A smaller yellow group includes Journal of Marketing and Research Policy, pointing to work on consumer behavior and innovation. Together, these clusters outline the main areas supporting research on corporate environmental responsibility. Based on the co-citation intensity and visualization clustering results, this study identifies four major source clusters as follows.

Table 5 – Four primary source clusters for citation source analysis

Cluster	Cluster Name	Research Focus	Representative Journals
Cluster 1	Core Cluster of Environmental Science and Policy Research (Red)	Environmental policy, energy economics, resource management	*Energy Policy*, *Ecological Economics*
Cluster 2	Mainstream Cluster of Management and Strategic Studies (Green)	Corporate strategy, organizational behavior, ethical theory	*Strategic Management Journal*, *Academy of Management Journal*, *Journal of Business Ethics*
Cluster 3	Operational Management and Sustainable Production Cluster (Blue)	Green production, resource efficiency, circular economy	*Journal of Cleaner Production*, *Sustainability*
Cluster 4	Marketing and Organizational Innovation Cluster (Yellow)	Market-driven innovation, consumer behavior	*Journal of Marketing*, *Research Policy*

Note – Compiled by authors based on VOSviewer

The Table 5 also shows changes in research direction. The center of the network is shaped by journals that link environmental strategy with firm decisions. Journal of Cleaner Production, Business Strategy and the Environment, and Sustainability form a dense core. Their topics mix environmental actions with performance and organizational change (Del Río et al., 2016; Hart & Dowell, 2011). Finance-related journals, including Energy Economics and Finance Research Letters, appear closer to this core than before. Their position suggests growing interest in how finance affects environmental actions, consistent with findings in ESG and sustainable finance work (Friede, Busch, & Bassen, 2015). Marketing and innovation outlets in the yellow cluster show that researchers now pay more attention to consumer responses and technology pathways (Kammerer, 2009; Schiederig, Tietze, & Herstatt, 2012). Overall, the field is moving toward broader and more mixed themes that bring together economics, strategy, operations, and innovation.

Analysis of Cited Authors

In order to further reveal the knowledge infrastructure of the research field of corporate environmental responsibility and green innovation, this paper carries out the co-citation analysis of cited authors based on the reference sources of the 497 documents collected. The minimum number of citations for cited authors was set at 20, and a total of 173 authors out of a total of 18,141 authors reached this threshold.

For these 173 authors, VOSviewer calculated the strength of their total co-cited links with other authors and generated a source co-citation network graph accordingly (see Figure 13). The size of the nodes in the graph indicates the authors' co-citation frequency, the thickness of the links between the nodes reflects the strength of the co-citation relationship, and the different colors indicate the different clusters identified by the software, representing the groups of authors who have been frequently co-cited in theoretical or empirical studies.

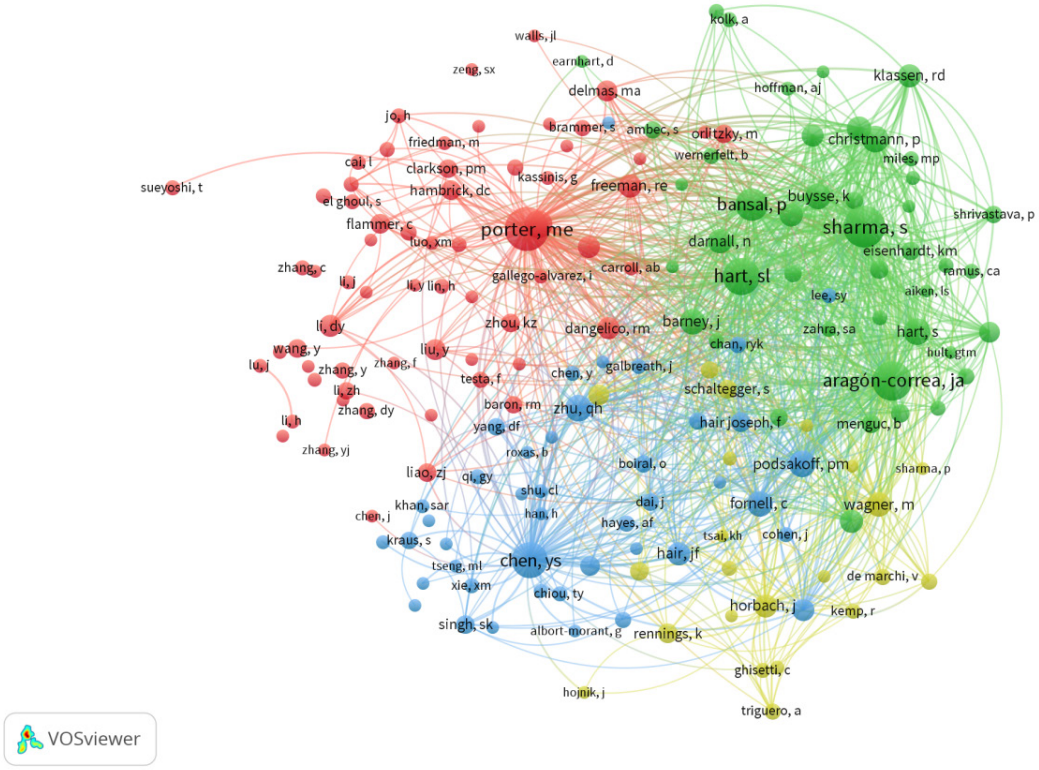

Figure 13 – Cited author analysis
Note – Compiled by authors based on VOSviewer

According to the results of the cluster analysis, the authors' co-citation network presents the following four main knowledge groups:

Category 1 (green): strategic environmental management and institutional theory research group. This cluster may differ somewhat from the red cluster in terms of topics or approaches, such as focusing on cross-disciplinary areas or specific application scenarios. Although the connectivity between nodes is relatively evenly distributed, the main authors still have connectivity in other clusters as well, showing that they play a bridging role, e.g., in interdisciplinary topics or methodologies. This cluster mainly includes key scholars such as Hart S.L., Sharma S., and Aragón-Correa J.A., whose research focuses on environmental strategy, dynamic capabilities, and the role of stakeholders in corporate sustainability.

Category 2 (red): CSR and Competitive Advantage Research Cluster. The high number of authors in this cluster and the high density of connectivity between the nodes imply that researchers within this cluster are closely related to each other in terms of research topics or theoretical paradigms, and that the literature is frequently cross cited. By observing the citation frequency and total link strength of the main authors, it can be inferred that this cluster usually focuses on a relatively centralized core topic, such as a certain theoretical framework or research methodology, which constitutes the foundation of earlier or more classical research in this field. Scholars represented by Porter M.E., Freeman R.E. and Clarkson P.M. constitute this category, with research focusing on how environmental and social responsibility can create shared value and thus enhance corporate competitiveness.

Category 3 (blue): Empirical Methods and Statistical Modeling Research Cluster. This cluster forms a tighter sub-network in the figure, reflecting a high degree of concentration and strong interaction among the core authors. The degree of internal differentiation may be relatively small, indicating that these authors are more consistent in their research focus or belong to the same school or team, thus forming a research paradigm or continuous research lineage with some consensus. This category focuses on methodological contributors such as Podsakoff P.M., Hair J.F., and Fornell C., who

provide statistical methods and empirical analytical models widely used in sustainability research.

Category 4 (Yellow): Environmental Innovation and Eco-Efficiency Research Cluster. Authors in the yellow cluster may focus primarily on areas that are at the intersection between traditional theories and emerging issues. For example, they may focus on new forms of self-expression in the context of the digital age, identity and social influence in social media, and interdisciplinary research issues driven by new technologies. In the yellow cluster, several core authors who are representative of cross-border integration, data-driven research and innovative theory construction can be identified through Total Link Strength (TLS) analysis. Their methodologies tend to be novel and may employ hybrid research methods, such as qualitative interviews combined with big data analysis, to address complex social behavioral phenomena in digital environments. The cluster includes scholars such as Rennings K., Ghisetti C., and De Marchi V., working on drivers of environmental innovation, policy incentives, and pathways to green technologies.

In summary, these four clusters of authors constitute the intellectual core of the research field, reflecting the interdisciplinary character of corporate environmental responsibility and green innovation research, integrating multiple academic fields such as strategic management, environmental economics, innovation theory and empirical methods.

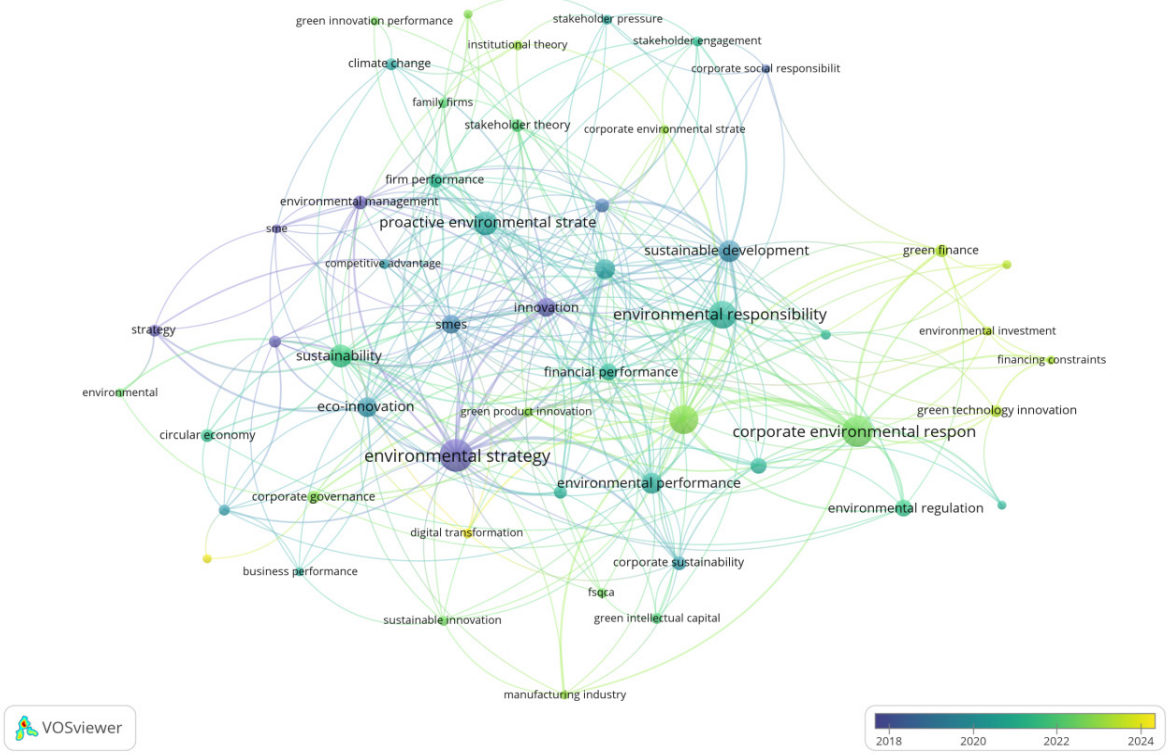

Figure 14 – Co-occurrence network visualization of author keywords
Note – Compiled by authors based on VOSviewer

Figure 14 visualizes the field's chronological metamorphosis through a temporal overlay. Rather than a static snapshot, the network illustrates a drift from the "cooler" indigo nodes of the foundational period (circa 2018–2019) toward the "warmer," luminous yellow clusters defining the current research horizon (2022–2024).

The historical anchor of this domain lies in the dense, dark-blue clusters surrounding "environmental strategy" and "environmental management." Research in this nascent phase was heavily predicated on internal organizational capabilities. It operated under the premise that pollution prevention was less a compliance issue and more a mechanism

for securing operational efficiency– a perspective deeply rooted in the Natural Resource-Based View (NRBV). Scholars during this period were primarily concerned with how firms could leverage proactive environmental postures to drive cost advantages (Aragon-Correa & Sharma, 2003; Christmann, 2000).

As the timeline progresses into the teal transition zone, the intellectual gravity shifts. The discourse moves away from purely strategic intent toward tangible implementation, evidenced by the prominence of "eco-innovation" and "sustainability." This era marks the point where environmental performance ceased to be viewed in isolation, becoming instead inextricably linked to a firm's technological outputs and competitive survival in regulated markets (Carrillo-Hermosilla et al., 2010; Chen et al., 2006).

In the most recent stratum, represented by the yellow nodes, the conversation has fundamentally externalized. The emergence of keywords such as "green finance," "digital transformation," and "financing constraints" suggests that the modern research agenda is no longer satisfied with internal management questions. Instead, contemporary inquiry scrutinizes the capital infrastructure required for sustainability. The current frontier asks not just if firms want to be green, but how financial technologies and capital allocation mechanisms enable– or restrict– their ability to do so (Gilchrist et al., 2021).

Conclusion

This study set out to make sense of how innovation has been used to frame, explain and expand corporate environmental responsibility (CER). Working with 497 articles allowed the analysis to trace not a single line of development but several threads that have gradually come together. Early work addressed CER through strategic behaviour and managerial commitment; later work turned toward innovation, performance, and institutional conditions. More recent studies link these themes to digital tools and new organisational routines. These shifts give the field a layered quality, where older and newer ideas coexist, overlap and – at times – compete with one another.

First, this study offers a consolidated map of the field's intellectual structure. The co-citation clusters make clear that CER research draws from at least three major knowledge centres: strategic environmental management, green innovation studies and operational environmental systems. Each centre advances its own vocabulary and evidence base, yet they intersect more often than scholars typically acknowledge.

Second, the analysis clarifies how innovation operates within CER scholarship. Rather than functioning as a single concept, innovation appears as a bridge that connects organisational capabilities, environmental performance, and institutional pressures. This perspective helps explain why the literature often reports different mechanisms yet still converges on similar outcomes.

Third, this study highlights structural imbalances in the evidence underpinning CER. Output is concentrated in a small number of countries– particularly China, Spain and the United States– while firms in transitional or resource-dependent settings remain underrepresented. These gaps limit the generalisability of existing theories and point to where empirical expansion is most needed.

Fourth, the coupling analysis uncovers several emerging fronts, including market-driven sustainability practices, data-enabled environmental governance and technology-centred CER innovation. These areas are gaining attention but still lack conceptual consolidation, suggesting important opportunities for future theory-building.

The implications of these findings run across academic, managerial and policy communities. For researchers, the field's fragmentation presents both a challenge and an opening: theoretical coherence requires more attention to how innovation, responsibility and organisational learning interact over time. For managers, the results imply that CER is not just a compliance domain but an arena where firms test new technologies, processes and governance models. For policymakers, the analysis reinforces the importance of institutional infrastructures– particularly information systems and regulatory incentives– in shaping how firms experiment with environmental practices.

This study has several limitations. Reliance on a single database means that parts of the global conversation remain outside the scope of the mapping. In addition, quantitative visualisation cannot fully capture how scholars use, contest or reshape concepts. Even so, the patterns identified here provide a stable foundation for further exploration.

Future research could look more closely at underrepresented organisational contexts, especially those in emerging and resource-dependent economies, where environmental responsibility evolves under different constraints. Work is also needed to understand how digital transformation reshapes CER,less in terms of tools and more in terms of organ is ational routines and learning processes. Stud-

ies integrating qualitative and longitudinal designs may be able to explain how innovations diffuse within firms and across sectors. These directions reflect a field still in motion, where new pressures and technologies continually reshape what environmental responsibility means in practice.

In closing, CER research continues to broaden and thicken. This study provides one way of seeing that landscape. It is likely that future research, working with new tools and new contexts, will redraw it again perhaps in ways that reveal connections still hidden today.

References

Aguilera-Caracuel, J., Hurtado-Torres, N. E., & Aragón-Correa, J. A. (2012). Does international experience help firms to be green? A knowledge-based view of how international experience and organisational learning influence proactive environmental strategies. Journal of World Business, 47(1), 130-142.

Aragon-Correa, J. A., & Sharma, S. (2003). A contingent resource-based view of proactive corporate environmental strategy. Academy of Management Review, 28(1), 71-88.

Aragon-Correa, J. A., & Sharma, S. (2003). A contingent resource-based view of proactive corporate environmental strategy. Academy of Management Review, 28(1), 71–88. https://doi.org/10.5465/amr.2003.8925233

Aragón-Correa, J. A., & Sharma, S. (2003). A contingent resource-based view of proactive corporate environmental strategy. Academy of Management Review, 28(1), 71–88.

Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11(4), 959-975.

Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11(4), 959–975. https://doi.org/10.1016/j.joi.2017.08.007

Bansal, P., & Roth, K. (2000). Why companies go green: A model of ecological responsiveness. Academy of Management Journal, 43(4), 717–736.

Callon, M., Courtial, J. P., & Laville, F. (1991). Co-word analysis as a tool for describing the network of interactions between basic and technological research: The case of polymer chemistry. Scientometrics, 22(1), 155-205.

Carrillo-Hermosilla, J., Del Río, P., & Könnölä, T. (2010). Eco-innovation: when sustainability and competitiveness shake hands. Journal of Cleaner Production, 18(10-11), 973-983.

Carrillo-Hermosilla, J., Del Río, P., & Könnölä, T. (2010). Eco-innovation: When sustainability and competitiveness shake hands. Journal of Cleaner Production, 18(10–11), 973–983. https://doi.org/10.1016/j.jclepro.2010.02.014

Chen, Y. S., Lai, S. B., & Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. Journal of Business Ethics, 67(4), 331-339.

Chen, Y. S., Lai, S. B., & Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. Journal of Business Ethics, 67(4), 331–339. https://doi.org/10.1007/s10551-006-9025-5

Christmann, P. (2000). Effects of "best practices" of environmental management on cost advantage: The role of complementary assets. Academy of Management Journal, 43(4), 663-680.

Christmann, P. (2000). Effects of "best practices" of environmental management on cost advantage: The role of complementary assets. Academy of Management Journal, 43(4), 663–680. https://doi.org/10.2307/1556360

Clarivate (2025.) Web of Science Core Collection. Retrieved from https://clarivate.com/webofsciencegroup/solutions/web-of-science-core-collection/ (Or a more appropriate citation if available)

Clarkson, M. B. E. (1995). A stakeholder framework for analyzing and evaluating corporate social performance. Academy of Management Review, 20(1), 92-117. (Note: Based on common citation context; verify if this is the intended Clarkson paper)

Del Río, P., Peñasco, C., & Romero-Jordán, D. (2016). What drives eco-innovators? A critical review of the empirical literature based on econometric methods. Journal of Cleaner Production, 112, 2158–2170.

Elkington, J. (1997). Cannibals with forks: The triple bottom line of 21st century business. Capstone. Freeman, R. E. (1984). Strategic management: A stakeholder approach. Pitman.

Freeman, R. E. (1984). Strategic management: A stakeholder approach. Pitman.

Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: Aggregated evidence from more than 2000 empirical studies. Journal of Sustainable Finance & Investment, 5(4), 210–233.

Gilchrist, D., Yu, J., & Zhong, R. (2021). The limits of green finance: A country-level analysis of the link between green finance and carbon emissions. Energy Economics, 102, 105557. https://doi.org/10.1016/j.eneco.2021.105557

Hart, S. L. (1995). A natural-resource-based view of the firm. Academy of Management Review, 20(4), 986-1014.

Hart, S. L., & Dowell, G. (2011). Invited editorial: A natural-resource-based view of the firm. Journal of Management, 37(5), 1464–1479.

Hojnik, J., & Ruzzier, M. (2016). What drives eco-innovation? A review of an emerging literature. Environmental Innovation and Societal Transitions, 19, 31-41.

Horbach, J., Rammer, C., & Rennings, K. (2012). Determinants of eco-innovations by type of environmental impact–The role of regulatory push/pull, technology push and market pull. Ecological Economics, 78, 112-122.

Kammerer, D. (2009). The effects of customer benefit and regulation on environmental product innovation. Ecological Economics, 68(8–9), 2285–2295.

Kessler, M. M. (1963). Bibliographic coupling between scientific papers. American Documentation, 14(1), 10-25.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. BMJ, 339, b2535. https://doi.org/10.1136/bmj.b2535

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71

Porter, M. E., & Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. Journal of Economic Perspectives, 9(4), 97-118.

Qi, G. Y., Zeng, S. X., Tam, C. M., Yin, H. T., & Wu, J. F. (2010). Integrating enterprise environmental responsibility into supply chain management in China. Journal of Cleaner Production, 18(16-17), 1620-1626.

Rennings, K. (2000). Redefining innovation– eco-innovation research and the contribution from ecological economics. Ecological Economics, 32(2), 319-332.

Rennings, K. (2000). Redefining innovation– Eco-innovation research and the contribution from ecological economics. Ecological Economics, 32(2), 319–332.

Russo, M. V., & Fouts, P. A. (1997). A resource-based perspective on corporate environmental performance and profitability. Academy of Management Journal, 40(3), 534-559.

Schiederig, T., Tietze, F., & Herstatt, C. (2012). Green innovation in technology and innovation management– An exploratory literature review. R&D Management, 42(2), 180–192.

Sharma, S., & Vredenburg, H. (1998). Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities. Strategic Management Journal, 19(8), 729-753.

Small, H. (1973). Co-citation in the scientific literature: A new measure of the relationship between two documents. Journal of the American Society for Information Science, 24(4), 265-269.

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. Journal of Business Research, 104, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. British Journal of Management, 14(3), 207–222. https://doi.org/10.1111/1467-8551.00375

van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics, 84(2), 523-538.

van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics, 84(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3

Wagner, M. (2007). On the relationship between environmental management, environmental innovation and patenting. Business Strategy and the Environment, 16(4), 275-290.

Zhu, Q., & Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. Journal of Operations Management, 22(3), 265-289.

Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. Organizational Research Methods, 18(3), 429-472. (Note: Cited for methodological context/justification within the Literature Review)

Information about authors:

Li’ang Zhang – PhD student, Department of Management, al-Farabi Kazakh National University, (Almaty, Kazakhstan, e-mail: zlachn@qq.com)

Turebekova Bazhan – PhD, King’s College London, intern researcher (London, United Kingdom), Department of Management, Candidate of Economic Sciences, al-Farabi Kazakh National University (Almaty, Kazakhstan, e-mail: k241232@kcl.ac.uk)

Sultan Dinara – PhD, University College London, United Kingdom (London, United Kingdom, e-mail: dinara.sultan.20@ucl.ac.uk

Авторлар туралы мәлімет:

Ли’анг Чжан – PhD докторанты, әл-Фараби атындағы ҚазҰУ, менеджмент кафедрасы (Алматы, Қазақстан, e-mail: zlachn@qq.com)

Туребекова Бажан – PhD, Лондон Корольдік Университеті, интерн-зерттеуші (Лондон, Ұлыбритания), әл-Фараби атындағы ҚазҰУ, менеджмент кафедрасы, экономика ғылымдарының кандидаты, (Алматы, Қазақстан, e-mail: k241232@kcl.ac.uk)

Султан Динара – PhD, Лондон Университеттік Колледжі (Лондон, Ұлыбритания, e-mail: dinara.sultan.20@ucl.ac.uk)

Сведения об авторах:

Лианг Чжан – PhD-докторант, Казахский национальный университет имени аль-Фараби, кафедра менеджмента (Алматы, Казахстан, e-mail: zlachn@qq.com).

Туребекова Бажан – интерн-исследователь, Королевский Колледж Лондона (Лондон, Великобритания, e-mail: k241232@kcl.ac.uk), Казахский национальный университет им. аль-Фараби, к. э. н. (Алматы, Казахстан).

Султан Динара – Университетский Колледж Лондона (Лондон, Великобритания, e-mail: dinara.sultan.20@ucl.ac.uk).

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